Biological Assessment Report

Black Creek
Shelby County, Missouri

2009 – 2010

Prepared for:

Missouri Department of Natural Resources
Division of Environmental Quality
Water Protection Program
Water Pollution Control Branch

Prepared by:

Missouri Department of Natural Resources
Division of Environmental Quality
Environmental Services Program
Water Quality Monitoring Section

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1.0 Introduction

At the request of the Water Protection Program (**WPP**), the Environmental Services Program (**ESP**) Water Quality Monitoring Section (**WQMS**) conducted a biological assessment of Black Creek. Black Creek is located in the Central Plains/Cuivre/Salt Ecological Drainage Unit (**EDU**) and originates near the town of Novelty in southwest Knox County. The stream is designated as a Class C stream (WBID 112) in the Missouri Water Quality Standards (MDNR 2010a) for 15 miles starting northwest of Leonard in Shelby County to the Highway 15 bridge crossing located near Shelbyville. The rest of Black Creek (19 miles, WBID 111) from Highway 15 to its confluence with the North Fork of the Salt River is designated as a Class P stream (Figure 1). Designated uses for Black Creek are "warm water aquatic life protection, human health/fish consumption, livestock and wildlife watering, and class B whole body contact" (MDNR 2010a). Black Creek has been selected for a targeted watershed project that will have the involvement of the Missouri Department of Natural Resources 319 Program and the Shelby County office of the Natural Resources Conservation Service (**NRCS**). This study was requested by the WPP so that baseline bioassessment and water quality data would be available in the future to help assess the effects of Best Management Practices that will be implemented by the targeted watershed project.

1.1 Study Area/Justification

The Black Creek watershed is primarily rural and most of the land use is made up of cropland (Figure 2). Row crops account for almost 70 percent of the land use in the upper part of the watershed and around 50 percent in the lower part of the watershed. The only discharging point source in the watershed is the Shelbyville Wastewater Treatment Facility (**WWTF**), which has a design flow of 0.07 million gallons per day (**MGD**). Non-point source pollution is potentially the greatest source of water pollution within the watershed, however, since cropland is the dominant land use.

1.2 Objectives

1) Assess the biological (macroinvertebrate) integrity and water quality of the Black Creek watershed.

2. Determine stream habitat quality.

1.3 Tasks

1) Conduct a biological assessment on Black Creek.

2) Conduct a stream habitat assessment at the sampling stations to ensure comparability of aquatic habitats.

3) Collect water samples and water quality field measurements at the bioassessment sampling stations and the major tributaries of the upper Black Creek watershed.

Figure 1
Map of Black Creek and Sampling Stations

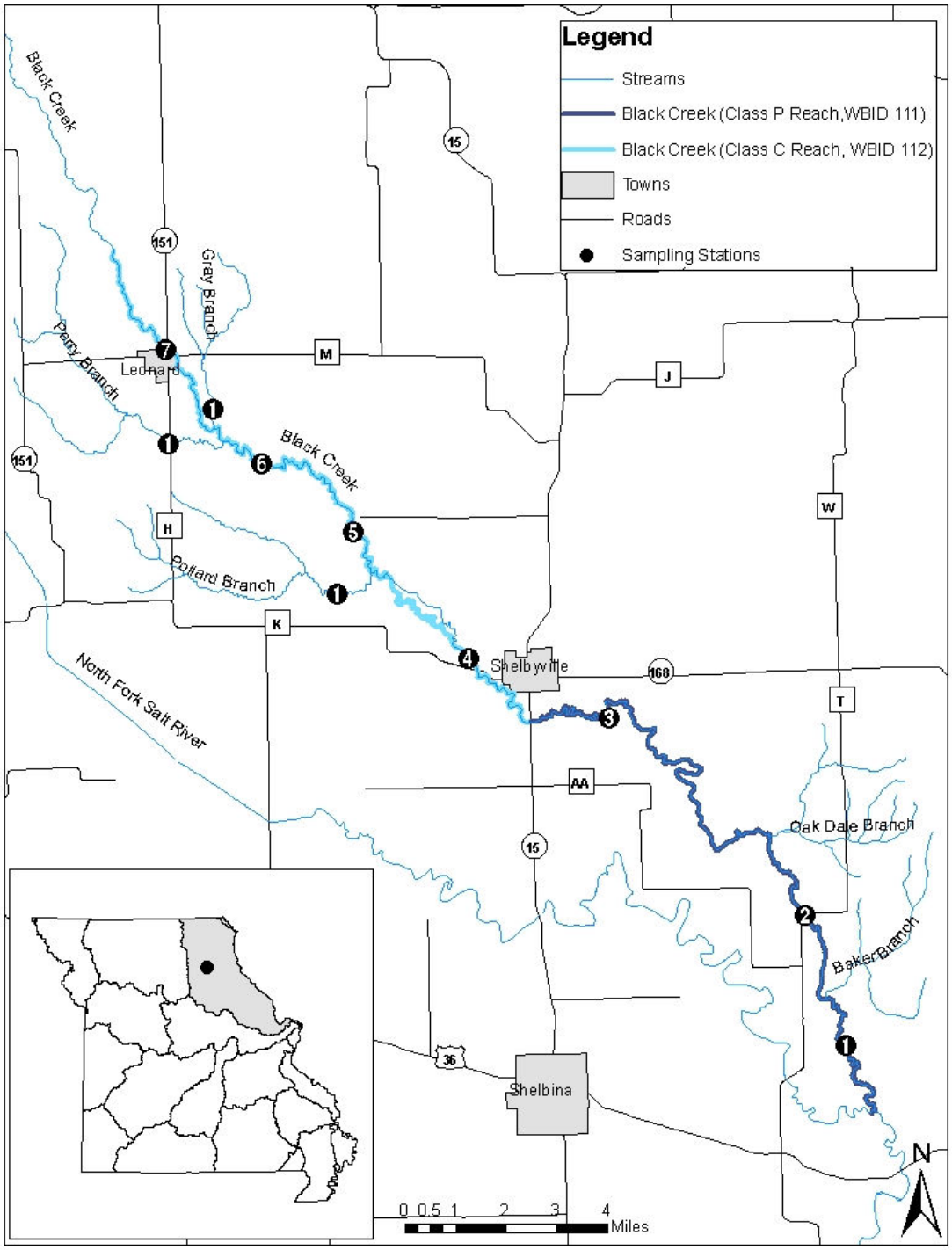
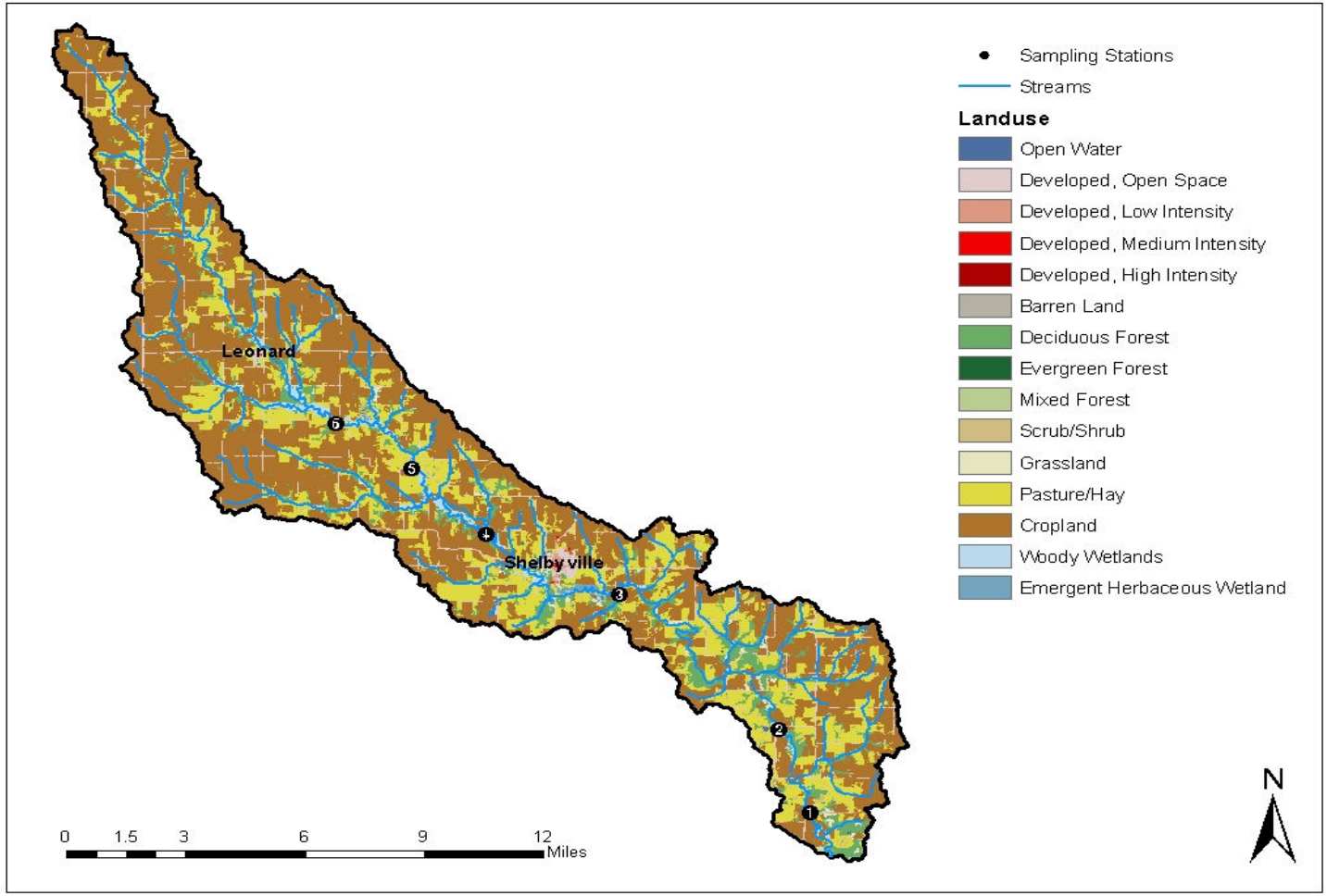


Figure 2
Land Use of the Black Creek Watershed



1.4 Null Hypotheses

1) The macroinvertebrate community will not differ among longitudinally separate reaches of Black Creek.

2) The macroinvertebrate community in Black Creek will not differ from the glide/pool biological criteria for the Central Plains/Cuivre/Salt EDU.

3) The stream habitat assessment scores will not differ among longitudinally separate reaches of Black Creek.

4) The stream habitat assessment scores in Black Creek will not differ from North River, a glide/pool biological criteria reference stream in the Central Plains/Cuivre/Salt EDU.

5) Physicochemical water quality in Black Creek will meet the Water Quality Standards (**WQS**) of Missouri (MDNR 2010a).

6) Physicochemical water quality will not differ among longitudinally separate reaches of Black Creek.

2.0 Methods

Carl Wakefield of the Biological Assessment Unit, Water Quality Monitoring Section, Missouri Department of Natural Resources, Division of Environmental Quality, Environmental Services Program conducted this study. Carl Wakefield and Mike Irwin of the Biological Assessment Unit collected samples and assessed stream habitat during the fall 2009 sampling season. The entire staff of the Biological Assessment Unit assisted in field work during the spring 2010 sampling season.

2.1 Study Timing

Macroinvertebrate and discrete water quality samples were collected at the sampling stations once during the fall 2009 and spring 2010 sampling seasons. Fall 2009 sampling was conducted on September 15-16, 2009 and spring 2010 sampling was conducted on April 13, 2010.

2.2 Station Descriptions

The study area and sampling locations for the Black Creek bioassessment study are shown in Figure 1. A total of six Black Creek stations were surveyed for bioassessment sampling and water quality. Water quality samples were also collected at an upstream Black Creek station and three of the larger tributaries of the upper Black Creek watershed.

2.2.1 Bioassessment Sampling Stations

Black Creek #1 – Shelby County: Legal description was NE¼ Sec. 32, T57N, R09W. Geographic coordinates were UTM zone 15, 0592409 Easting, 4395335 Northing. Station located downstream of County Road 478.

Black Creek #2 – Shelby County: Legal description was SW¼ Sec. 17, T57N, R09W. Geographic coordinates were UTM zone 15, 0591160 Easting, 4399212 Northing. Station located upstream of Highway T.

Black Creek #3 – Shelby County: Legal description was SW¼ Sec. 27, T58N, R10W. Geographic coordinates were UTM zone 15, 0584733 Easting, 4405329 Northing. Station located upstream of County Road 349.

Black Creek #4 – Shelby County: Legal description was SW¼ Sec. 19, T58N, R10W. Geographic coordinates were UTM zone 15, 0580065 Easting, 4407251 Northing. Station located upstream of Highway K.

Black Creek #5 – Shelby County: Legal description was NE¼ Sec. 10, T58N, R11W. Geographic coordinates were UTM zone 15, 0576298 Easting, 4411124 Northing. Station located downstream of County Road 226.

Black Creek #6 – Shelby County: Legal description was NE¼ Sec. 5, T58N, R11W. Geographic coordinates were UTM zone 15, 0573288 Easting, 4413242 Northing. Station located upstream of County Road 127.

2.2.2 Additional Water Quality Sampling Stations

Black Creek #7 – Shelby County: Legal description was NW¼ Sec. 30, T59N, R11W. Geographic coordinates were UTM zone 15, 0570520 Easting, 4416557 Northing. Station located downstream of Highway M.

Perry Branch #1 – Shelby County: Legal description was SE¼ Sec. 36, T59N, R12W. Geographic coordinates were UTM zone 15, 0570197 Easting, 4413947 Northing. Station located upstream of Highway H.

Gray Branch #1 – Shelby County: Legal description was SW¼ Sec. 29, T59N, R11W. Geographic coordinates were UTM zone 15, 0571721 Easting, 4414937 Northing. Station located upstream of County Road 134.

Pollard Branch #1 – Shelby County: Legal description was NW¼ Sec. 15, T58N, R11W. Geographic coordinates were UTM zone 15, 0575694 Easting, 4409310 Northing. Station located upstream of County Road 227.

2.3 MoRAP Aquatic Ecological Classification

The aquatic ecological classification developed by the Missouri Resource Assessment Partnership (**MoRAP**) is a classification system that divides the aquatic resources of Missouri into distinct regions. It has seven levels of classification starting at large regions and then dividing them into smaller subregions (Sowa et. al. 2004). The following are the seven levels of classification in hierarchical order: zone, subzone, region, aquatic subregions, EDU, Aquatic Ecological Systems (**AES**), and Valley Segment Types (**VST**). The levels of classification are based on biology, zoogeography, taxonomic composition, geology, soils, and groundwater connection. Some levels of the hierarchical system use geology and soils to classify and other levels use biology and taxonomic composition of aquatic communities. Ecological Drainage Units and AES are the two levels of the classification that will be assessed in detail for this study.

2.3.1 Ecological Drainage Unit

The EDU is level five of the classification hierarchy and is based on geographical variation of the taxonomic composition of the level four subregions. An EDU is a region in which aquatic biological communities and habitat conditions can be expected to be similar. Table 1 compares the land cover percentages from the Central Plains/Cuivre/Salt EDU, North River biological criteria reference station watershed, and the Black Creek sampling stations upstream of the sampling locations. Land cover data were derived from Thematic Mapper satellite data from 2000 to 2004 for the entire EDU and from the 2001 national land cover database for the sampling station watersheds. Compared to the North River and the entire Central Plains/Cuivre/Salt EDU, land use at the Black Creek sampling stations was much higher for percent crops and much lower for percent forest. The amount of row crops made up a larger percentage in the upper part of the watershed than the lower part of the watershed.

2.3.2 Aquatic Ecological Systems

Aquatic Ecological Systems are level six of the classification hierarchy and classify aquatic systems into AES types based on geology, soils, landform, and groundwater influence. Black Creek is located in the Lick Creek AES type. The Lick Creek AES type is made up of two distinct subregions. The eastern part of the AES type in the Central Plains/Cuivre/Salt EDU is more similar to Ozark border regions than the western section, which is much more prairie-like (Sowa and Diamond 2006). Black Creek is located in the western section of the Lick Creek AES type and, like other streams that flow through the western section, has a stream channel made up of sand, silt, and clay. Streams in this section tend to be meandering, low gradient systems with narrow watersheds. The western section of the Lick Creek AES is made up primarily of Pennsylvanian limestones that transition to Mississippian limestone nearer to the Mississippi River. Claypan soils on a flat to gently rolling topography are common in the western section of the AES type. Most of the local relief for the entire Lick Creek AES is 98 feet, but occasionally approaches 197 feet in some locations.

Table 1
Percent Land Cover

Land Cover	Urban	Crops	Grassland	Forest	Wetland
Central Plains/Cuivre/Salt EDU	2	49	28	14	3
North River #1	4	44	30	18	3
Black Creek #1	4	58	25	8	3
Black Creek #2	4	59	25	8	3
Black Creek #3	5	62	22	7	3
Black Creek #4	4	66	20	6	3
Black Creek #5	4	66	21	5	3
Black Creek #6	4	67	20	5	3
Black Creek #7	5	68	21	4	2
Perry Branch #1	4	69	18	5	3
Gray Branch #1	3	71	18	6	1
Pollard Branch #1	3	72	17	7	1

2.4 Stream Habitat Assessment

A standardized assessment procedure was followed as described for glide/pool habitat in the Stream Habitat Assessment Project Procedure (**SHAPP**) (MDNR 2010b). The habitat assessment was conducted on all stations during September of 2009.

2.5 Biological Assessment

Biological assessments consisted of macroinvertebrate collection and physicochemical sampling for two sample periods.

2.5.1 Macroinvertebrate Collection and Analysis

A standardized macroinvertebrate sample collection and analysis procedure was followed as described in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**) (2010c) for glide/pool (**GP**) streams. Three standard habitats, depositional substrate in non-flowing water (**NF**), large woody debris (**SG**), and root mat (**RM**), were collected at the sampling stations.

Macroinvertebrate data were analyzed using two methods. The first analysis was calculating the Macroinvertebrate Stream Condition Index (**MSCI**) using the biological criteria for perennial/wadeable streams from the Central Plains/Cuivre/Salt EDU using the four general biological metrics found in the SMSBPP (MDNR 2010c). The four general biological metrics used and found in the SMSBPP are: 1) Taxa Richness (**TR**); 2) Ephemeroptera/Plecoptera/Trichoptera Taxa (**EPTT**); 3) Biotic Index (**BI**); and 4) Shannon Diversity Index (**SDI**). The second analysis was an evaluation of macroinvertebrate community composition by percent composition of dominant macroinvertebrate groups. Comparisons of the macroinvertebrate community among the Black Creek test stations also were made.

2.6 Physicochemical Data Collection and Analysis

2.6.1 *In Situ* Water Quality Measurements

During each sampling period, *in situ* water quality measurements were collected at all of the bioassessment and additional water quality sampling stations. Field measurements included water temperature (°C), dissolved oxygen (mg/L), conductivity (µS/cm), and pH.

2.6.2 Water Chemistry

Grab samples of stream water were collected and submitted to ESP's Chemical Analysis Section. Surface water samples from the bioassessment stations were analyzed for total suspended solids, turbidity, chloride, total phosphorus, ammonia-N, nitrate + nitrite-N, and total nitrogen. Samples from the additional water quality sampling stations were analyzed for total suspended solids. Procedures outlined in Field Sheet and Chain-of-Custody Record, Standard Operating Procedure (**SOP**) MDNR-ESP-002, (MDNR 2010d) and Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations, SOP MDNR-ESP-001, (MDNR 2009) were followed

when collecting water quality samples. Stream velocity was measured at each station during the survey period using a Marsh-McBirney Flo-Mate™ Model 2000. Discharge was calculated per the methods in the SOP MDNR-ESP-113, Flow Measurement in Open Channels (MDNR 2010e).

2.7 Data Analysis and Quality Control

The physicochemical data were examined by variable to identify stations that had violations of the Missouri Water Quality Standards (MDNR 2010a). Sampling stations that had values that were higher or lower than the water quality standards will be discussed with possible influences being identified.

3.0 Results

3.1 Stream Habitat Assessment

Habitat assessment scores and physical characteristics for the Black Creek test stations and the North River biological criteria reference station are shown in Tables 2 and 3. Habitat data were collected in September 2009, with Carl Wakefield and Mike Irwin performing the scoring. SHAPP guidance states that test stations scoring at least 75 percent of the total score of reference/control stations should support a similar biological community. The stream habitat total scores indicated that the Black Creek test stations, except station #1, should support a similar macroinvertebrate community to the North River biological criteria reference station. The Black Creek station #1 habitat score of 93 was lower than the 75 percent value of the North River habitat score of 133. The only other station that was close to being habitat limited was station #6 with a habitat score of 100, which was 75.2 percent of the North River habitat score. Marginal quality for epifaunal substrate, pool variability, channel sinuosity, and poor quality for vegetative protection of banks and riparian zone led to a poor overall habitat score for station #1. At station #6, marginal quality for pool variability, sediment deposition, channel flow status, left bank stability, and poor quality for epifaunal substrate, vegetative protection of banks, and right bank riparian zone led to the lower score.

Among other test stations, epifaunal substrate was marginal or poor and sedimentation was high at stations #2 and #3. Bank stability was generally good, but vegetative protection of the banks was poor. The riparian zone was mixed at these stations. Stations #2 and #3 had very good riparian zones, but at stations #4 and #5 one bank was in good condition, but the other bank was either in marginal or poor condition.

3.2 Macroinvertebrate Biological Assessment

3.2.1 Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP)

Macroinvertebrate Stream Condition Index scores were calculated at Black Creek test stations using the glide/pool perennial/wadeable biological criteria for the Central Plains/Cuivre/Salt EDU. MSCI scores for the fall 2009 sampling season are shown in

Table 2
Predominant Category Habitat Values, Category Habitat Scores, and Total Habitat Scores from Stream Habitat Assessments for the Black Creek Test Stations and the North River Biological Criteria Reference Station

	Black Creek #1	**Black Creek #2**	**Black Creek #3**	**Black Creek #4**	**Black Creek #5**	**Black Creek #6**	**North River #1**
Sample Date	09/15/09	09/15/09	09/15/09	09/16/09	09/16/09	09/16/09	09/17/09
Stream Habitat Parameters							
Epifaunal Substrate/Available Cover	III (6)	III (6)	IV(5)	IV (4)	IV (2)	IV (5)	III (7)
Pool Substrate Characterization	II (15)	II (13)	II (12)	II (11)	II (13)	II (15)	I (16)
Pool Variability	III (10)	I (18)	III (10)	III (10)	I (16)	III (10)	III (8)
Sediment Deposition	IV (4)	III (7)	III (8)	I (19))	II (11)	III (8)	I (17)
Channel Flow Status	II (12)	III (9)	II (13)	I (18)	II (12)	III (8)	II (13)
Channel Alteration	II (15)	I (20)	I (20)	I (20)	I (20)	I (20)	I (20)
Channel Sinuosity	III (8)	III (6)	II (11)	III (8)	III (8)	III (9)	I (19)
Bank Stability – Left Bank	I (9)	I (9)	II (7)	I (9)	I (9)	III (5)	II (8)
Bank Stability – Right Bank	II (8)	I (9)	II (8)	II (7)	III (4)	II (7)	I (10)
Vegetative Protection – Left Bank	IV (1)	IV (2)	IV (1)	IV (2)	III (5)	IV (1)	IV (1)
Vegetative Protection – Right Bank	IV (1)	IV (2)	IV (0)	IV (1)	IV (1)	IV (0)	IV (2)
Riparian Zone Width – Left Bank	IV (2)	I (9)	I (10)	I (9)	III (5)	I (9)	III (5)
Riparian Zone Width – Right Bank	IV (2)	I (9)	I (10)	IV (2)	I (9)	IV (2)	II (7)
Total Habitat Score	93	119	115	120	115	100	133

Habitat parameter categories range from I to IV with category I = optimal, category II = suboptimal, category III = marginal, and category IV = poor. Habitat parameter scores are listed in parentheses and range from 0 to 20 except for vegetative protection and riparian zone categories which range from 0 to 10.

Table 3
Physical Characteristics of the Black Creek Bioassessment Sampling Reaches Based on Values from the MoRAP Valley Segment Types (VST) Geographic Information Systems (GIS) Layer

	Black Creek #1	Black Creek #2	Black Creek #3	Black Creek #4	Black Creek #5	Black Creek #6	North River #1
Watershed Area (mi^2)	111	103	79	64	47	39	171
Strahler Order	4	4	3	3	3	3	5
Link Magnitude	53	49	34	27	20	16	98
Stream Gradient (feet/mile)	1.49	4.83	2.08	2.73	3.88	3.78	5.31
Relative Gradient	Low	Medium	Medium	Medium	Medium	Medium	Medium
Sinuosity (mile/mile)	1.51	1.24	1.81	1.31	1.42	1.41	2.40
Temperature Regime	Warm	Warm	Warm	Warm	Warm	Warm	Warm
Stream Size	Small River	Small River	Small River	Creek	Creek	Creek	Small River
Flow Regime	Permanent	Permanent	Permanent	Permanent	Permanent	Permanent	Permanent
Geology	Limestone	Limestone	Limestone	Limestone	Limestone	Limestone	Limestone

Table 4 and in Table 5 for the spring 2010 sampling season. Each of the Black Creek test stations had MSCI scores of 16 and was in the fully supporting category during the fall 2009 sampling season, with the exception of stations #3 and #6. Test stations #3 and #6 MSCI scores were in the partially supporting category with a score of 12 at test station #3 and 14 at test station #6. At station #3, the low score was caused by a very low EPTT value, a slightly lower TR value, and a slightly higher BI value compared to the biological criteria. The MSCI score at test station #6 was caused by a slightly lower TR, EPTT, and slightly higher BI value compared to the biological criteria. At the other test stations, slightly lower EPTT and slightly higher BI values compared to the biological criteria led to the MSCI scores of 16.

All of the Black Creek test stations during the spring 2010 sampling season had MSCI scores in the fully supporting category with one station scoring 16, three scoring 18, and two stations scoring 20 (Table 5). Test station #3 had the lowest MSCI score of 16, which was caused by a higher biotic index value and a slightly lower EPTT score when compared to the biological criteria. Black Creek #6 had an MSCI of 18 though it had lower values for TR, EPTT, and SDI than the other test stations.

Table 4
Fall 2009 Glide/Pool Central Plains/Cuivre/Salt EDU Perennial/Wadeable Biological Criteria, Biological Support Categories, and Macroinvertebrate Stream Condition Index (MSCI) Scores at the Black Creek Test Stations

Stream and Station Number	Sample No.	TR	EPTT	BI	SDI	MSCI	**Support**
Black Creek #1	0918433	60	8	7.20	3.16	16	F
Black Creek #2	0918434	64	9	7.60	3.03	16	F
Black Creek #3	0918435	56	4	7.40	3.09	12	P
Black Creek #4	0918436	64	9	7.10	3.35	16	F
Black Creek #5	0918437	61	5	7.5	3.14	16	F
Black Creek #6	0918438	56	6	7.3	3.06	14	P
Metric Score=5	If	>59	>11	<6.80	>2.90	20-16	**F**ull
Metric Score=3	If	59-29	11-5	6.80-8.40	2.90-1.45	14-10	**P**artial
Metric Score=1	If	<29	<5	>8.40	<1.45	8-4	**N**on

MSCI Scoring Table (in light gray) developed from BIOREF stream samples (n=6);
TR=Taxa Richness; EPTT=Ephemeroptera, Plecoptera, Trichoptera Taxa; BI=Biotic Index;
SDI=Shannon Diversity Index

Table 5
Spring 2010 Glide/Pool Central Plains/Cuivre/Salt EDU Perennial/Wadeable Biological Criteria, Biological Support Categories, and Macroinvertebrate Stream Condition Index (MSCI) Scores at the Black Creek Test Stations

Stream and Station Number	Sample No.	TR	EPTT	BI	SDI	MSCI	**Support**
Black Creek #1	1004052	60	7	7.20	3.11	18	F
Black Creek #2	1004051	66	8	6.90	3.36	20	F
Black Creek #3	1004053	60	7	7.50	3.08	16	F
Black Creek #4	1004054	63	8	7.10	3.13	20	F
Black Creek #5	1004055	60	9	7.20	3.16	18	F
Black Creek #6	1004056	56	5	7.10	2.82	18	F
Metric Score=5	If	>49	>7	<7.20	>2.09	20-16	**F**ull
Metric Score=3	If	49-25	7-3	7.20-8.60	2.09-1.05	14-10	**P**artial
Metric Score=1	If	<25	<3	>8.60	<1.05	8-4	**N**on

MSCI Scoring Table (in light gray) developed from BIOREF stream samples (n=6);
TR=Taxa Richness; EPTT=Ephemeroptera, Plecoptera, Trichoptera Taxa; BI=Biotic Index; SDI=Shannon Diversity Index

3.2.2 Macroinvertebrate Percent and Community Composition

The percent composition of EPTT, sensitive taxa, functional feeding groups (FFG), functional habitat groups (FHG), and the five dominant macroinvertebrate families and taxa at each station are presented in Tables 6 through 9. Values in bold type represent the five dominant macroinvertebrate families and taxa for each station.

3.2.2.1 Percent Sensitive Taxa

The macroinvertebrate community was made up of primarily tolerant taxa during both sampling seasons. Taxa from the test station samples that had biotic index values between 5.0 and 7.5 made up from 33 to 51 percent of the samples during the fall 2009 (Table 6) sampling season and from 43 to 60 percent during spring 2010 (Table 8). The percent of samples made up of taxa with biotic index values between 7.5 and 10.0 ranged from 45 to 64 percent during fall 2009 and from 36 to 55 percent during the spring 2010 sampling season. Taxa with biotic index values below 5.0 made up a very small portion for most of the test station samples compared to the glide/pool biological criteria data for the Central Plains/Cuivre/Salt EDU. The only exception to this trend occurred at Black Creek #1 and #2 during spring 2010, which had values that were very similar to the Central Plains/Cuivre/Salt EDU biological criteria data.

3.2.2.2 Functional Feeding Groups (FFG) and Functional Habitat Groups (FHG)
Although gatherer-collectors were the most common FFG in the fall 2009 macroinvertebrate samples, this FFG was lower than the biological criteria data at all but station #2 (Table 6). At test station #2, gatherer-collectors were slightly higher than biological criteria. Filterers made up from 16 to 22 percent of the test station samples, which was similar to the reference conditions. With the exception of station #6, predators were higher at the test stations compared to biological criteria data. Scrapers made up from 6 to 13 percent of the test station samples, which was lower than the reference condition value of 16. With the exception of station #2, shredders were higher among test stations compared to biological criteria reference conditions. Shredders ranged from 4 percent at station #2 to 13 percent at station #6 in fall 2009.

Clingers made up a large portion of the fall 2009 test station samples with values slightly lower than or similar to the biological criteria reference condition at all of the test stations, except stations #1 and #3 (Table 6). Climbers also made up a large portion of the test station samples with values at the four downstream stations being higher than reference conditions, whereas the two most upstream stations were about 5 percent lower than reference conditions. Burrowers showed a trend of being more abundant at the upstream stations, ranging from 15 percent at station #1 to 27 percent at station #5, with values greater than reference conditions at all of the stations except station #1. Sprawlers were abundant in the test station samples and were present in higher percentages than reference conditions, except at station #6. Sprawlers ranged from 11 percent at station #6 to 20 percent at station #2. Swimmers, which ranged from 1 percent at station #2 to 9 percent at station #5, were lower than the reference condition value of 10 percent.

Gatherer-collectors were the most common FFG during the spring 2010 sampling season at the test stations, making up 43 to 52 percent of the samples. This range is very similar to the biological criteria data for this FFG (Table 7). After gatherer-collectors, filterers and shredders were the two most common FFGs. Filterers made up from 12 to 18 percent of the test station samples and were much higher than reference conditions. Shredders made up 7 to 23 percent of the test station samples and were lower than reference conditions at test stations #1, #2, and #3, but shredders were higher at the remaining test stations. Predators were common among most test streams, making up 4 to 13 percent of the samples, which was higher than reference conditions. Scrapers were much lower in abundance at test stations compared to reference conditions, making up 3 to 12 percent of samples.

Clingers were the most common FHG in the spring 2010 test station samples, making up 19 to 34 percent of samples (Table 7). Clinger values at test stations, except station #3, were similar to or slightly higher than reference conditions for the Central Plains/Cuivre/Salt EDU. Other FHG that were common in test samples were burrowers, climbers, and sprawlers. Burrowers made up from 15 to 34 percent of samples and were similar to reference conditions at test stations #1 through #4, but were much higher at the two upstream test stations. Climbers were higher at the four downstream stations

Table 6
Biological Metric Values for Sensitive Taxa, Functional Feeding Groups (FFG), and Functional Habitat Groups (FHG) at the Black Creek Test Stations and the Biological Criteria Reference Samples, Fall 2009

Variable-Station	**Biocriteria Reference Data**	**Black Creek #1**	**Black Creek #2**	**Black Creek #3**	**Black Creek #4**	**Black Creek #5**	**Black Creek #6**
Sample Number		0918433	0918434	0918435	0918436	0918437	0918438
Sensitive Taxa							
% Biotic Index >9.0	7.89	3.75	13.74	7.52	10.58	14.95	16.38
% Biotic Index 7.5-9.0	39.09	41.25	50.95	47.99	36.11	46.91	36.11
% Biotic Index 5.0-7.5	36.87	51.93	33.60	42.37	47.61	36.19	40.90
% Biotic Index 2.5-5.0	7.60	2.61	1.50	0.95	2.75	0.65	0.61
% Biotic Index < 2.5	8.56	0.45	0.20	1.17	2.95	1.30	6.00
FFG Metrics							
% Filterers	19.79	20.66	19.33	18.91	16.51	19.34	22.51
% Gatherer Collectors	39.65	36.71	42.15	29.99	32.60	33.35	34.44
% Parasites	1.63	0.79	0.74	3.01	3.21	2.25	1.78
% Piercers	3.89	6.18	3.74	6.89	8.31	8.76	4.37
% Predators	9.20	13.68	13.07	17.41	18.23	16.40	7.50
% Scrapers	15.86	9.61	13.07	10.46	10.33	6.32	12.18
% Shredders	7.51	9.08	4.05	10.65	8.67	12.08	13.16
FHG Metrics							
% Burrowers	15.62	14.99	17.16	18.24	21.34	26.55	26.41
% Clingers	28.98	31.03	23.25	32.01	22.85	21.93	28.77
% Climbers	18.17	27.74	26.99	20.07	20.29	12.20	13.46
% Divers	0.05	0.08	0.07	0	0	0	0
% Skaters	0.16	0	0.07	0.29	0	0	0.15
% Sprawlers	11.55	18.22	20.35	15.68	18.33	13.27	11.24
% Swimmers	9.79	2.85	1.18	2.20	4.68	8.66	5.10

Table 7
Biological Metric Values for Sensitive Taxa, Functional Feeding Groups (FFG), and Functional Habitat Groups (FHG) at the Black Creek Test Stations and the Biological Criteria Reference Samples, Spring 2010

Variable-Station	**Biocriteria Reference Data**	**Black Creek #1**	**Black Creek #2**	**Black Creek #3**	**Black Creek #4**	**Black Creek #5**	**Black Creek #6**
Sample Number		1004052	1004051	1004053	1004054	1004055	1004056
Sensitive Taxa							
% Biotic Index >9	14.63	12.16	8.37	16.22	8.70	11.32	13.22
% Biotic Index 7.5-9	31.26	32.53	33.89	38.98	38.00	33.59	23.22
% Biotic Index 5-7.5	44.57	47.97	47.81	42.92	50.46	51.15	60.44
% Biotic Index 2.5-5.0	8.39	7.23	9.06	1.61	2.75	3.84	2.44
% Biotic Index <2.5	1.16	0.11	0.88	0.27	0.09	0.10	0.67
FFG Metrics							
% Filterers	7.81	17.93	16.63	14.24	14.16	17.04	11.83
% Gatherer Collectors	47.57	46.07	43.26	50.61	46.37	47.71	51.87
% Parasites	0.30	0.57	1.83	0.42	1.71	0.70	0.92
% Piercers	1.66	3.36	4.06	3.60	4.06	1.44	1.18
% Predators	3.92	9.06	10.00	8.15	12.55	7.83	4.01
% Scrapers	20.69	7.92	7.83	3.23	11.97	4.06	5.06
% Shredders	16.78	12.80	12.23	17.63	7.37	17.86	23.01
FHG Metrics							
% Burrowers	20.17	19.69	14.81	19.59	22.18	34.46	29.42
% Clingers	27.03	31.69	27.21	31.64	19.06	27.22	33.56
% Climbers	18.48	24.42	26.27	21.85	20.96	10.06	10.46
% Divers	0.09	0	0	0	0.07	0.07	0.08
% Skaters	0.02	0	0	0	0	0	0
% Sprawlers	28.71	14.39	19.44	12.81	26.26	14.21	13.54
% Swimmers	2.06	0.44	0.60	0.31	0.47	0.42	0.83

compared to reference conditions, but were much lower at the two most upstream stations, making up from 10 to 26 percent of the samples. Except at test station #4, sprawlers were much less abundant than reference conditions, making up from 13 to 26 percent of the samples. Swimmers were found in low abundance at all of the test stations and were lower than reference conditions, making up less than 1 percent of the samples.

3.2.2.3 Dominant Macroinvertebrate Families and Taxa

Chironomidae was the most abundant family found in the fall 2009 Black Creek macroinvertebrate samples (Table 8). Chironomids common in samples were *Dicrotendipes* and *Tanytarsus* at all sampling stations, *Glyptotendipes* at test stations #3 through #6, *Paratanytarsus* and *Tribelos* at test station #6, *Polypedilum halterale* group at test station #1, and *Thienemannimyia* group at test station #4. Mayflies *Caenis latipennis* and *Stenacron* were the only EPTT that were common in some of the samples. EPT taxa made up a much lower percentage of test samples than reference conditions and were lowest at the two most upstream stations. Other macroinvertebrate taxa that were common in some of the Black Creek samples were the coenagrionid damselfly *Argia*, tubificid worms, water boatmen (Corixidae), and the amphipod *Hyalella azteca*.

Chironomidae was the most abundant family found in the spring 2010 Black Creek macroinvertebrate samples and was more abundant than reference conditions for the Central Plains/Cuivre/Salt EDU (Table 9). Chironomids common in samples were *Cricotopus/Orthocladius* group, *Dicrotendipes* and *Tanytarsus* at all test stations, *Parakiefferiella* at test stations #2, #4, #5, and #6, *Polypedilum scalaenum* group at test stations #2 and #3, *Thienemannimya* group at the four most downstream test stations, and *Glyptotendipes* at test station #5. *Caenis latipennis* was abundant at test stations #1, #2, and #4 and was the only EPTT consistently found in samples. The percentage of samples made up of EPTT was much lower than reference conditions and extremely low at test stations #3, #5, and #6. The only other common macroinvertebrate taxa group was tubificid worms.

Table 8
Percent EPT, Dominant Macroinvertebrate Families, and Taxa at the Black Creek Test Stations during the Fall 2009 Sampling Season

Variable-Station	**Biocriteria Data**	**Black Cr #1**	**Black Ck #2**	**Black Ck #3**	**Black Cr #4**	**Black Cr #5**	**Black Cr #6**
EPT Metrics							
% EPT	21.8 ± 2.6	13.3	18.0	12.8	13.9	8.3	9.3
% Ephemeroptera	20.0 ± 2.4	13.0	17.1	12.8	12.7	8.0	8.4
% Plecoptera	0	0	0	0	0	0	0
% Trichoptera	1.9 ± 0.3	0.3	0.8	0	1.2	0.3	0.8
Percent Dominant Families							
Chironomidae	**43.8 ± 3.2**	**68.1**	**53.4**	**58.6**	**60.2**	**54.2**	**68.3**
Coenagrionidae	2.6 ± 0.2	**9.4**	**9.0**	**9.1**	**7.3**	2.5	0.9
Caenidae	**7.2 ± 0.5**	**8.1**	**14.6**	**4.9**	**6.8**	**3.9**	0.4
Baetidae	0.7 ± 0.2	**3.2**	0.7	0.4	0.2	0	0
Elmidae	**5.6 ± 0.6**	**3.1**	**3.7**	0	0.1	0	0
Tubificidae	2.2 ± 0.3	0.7	**10.7**	3.6	**3.9**	**4.3**	**5.2**
Arachnoidea	2.8 ± 0.6	1.4	1.0	**4.7**	**5.4**	3.8	2.8
Heptageniidae	2.6 ± 0.3	1.3	1.4	**6.4**	2.6	2.6	2.0
Corixidae	3.6 ± 0.6	0.3	0.1	1.6	2.4	**10.1**	0.7
Hyalellidae	**8.4 ± 1.8**	0.3	0.5	1.2	0.8	**9.5**	0.6
Leptophlebidae	**8.5 ± 1.6**	0.4	0.2	1.2	2.9	1.2	**6.0**
Physidae	3.1 ± 0.7	0.2	0.2	0.3	1.4	1.3	**5.2**
Planorbidae	0.4 ± 0.1	1.4	1.9	2.9	1.9	1.0	**4.0**
Percent Dominant Taxa							
Dicrotendipes	**10.0 ± 1.2**	**12.2**	**14.9**	**6.9**	**10.3**	**11.7**	**9.9**
Glyptotendipes	**7.5 ± 1.4**	4.8	3.2	**13.2**	**6.2**	**13.5**	**12.8**
Paratanytarsus	0.1 ± 0.0	3.0	3.2	4.0	3.1	2.2	**6.3**
Polypedilum halterale grp.	0.6 ± 0.1	**6.9**	0.4	0.2	1.0	0.1	0.9
Tanytarsus	8.3 ± 0.7	**14.6**	**11.0**	**10.5**	**9.0**	**7.2**	**13.4**
Thienemannimya group	0.9 ± 0.2	4.6	2.3	4.7	**6.5**	2.8	0.8
Tribelos	0.8 ± 0.1	2.1	2.2	3.0	4.9	1.0	**6.8**
Argia	2.1 ± 0.2	**8.5**	**9.0**	**8.9**	4.8	1.5	0.5
Caenis latipennis	**6.4 ± 0.5**	**8.1**	**14.6**	4.9	**6.8**	3.9	0.4
Tubificidae	1.4 ± 0.2	0.7	**9.8**	3.4	3.6	3.7	5.2
Stenacron	2.0 ± 0.2	0.8	1.4	**6.4**	2.6	2.6	2.0
Corixidae	3.6 ± 0.6	0.3	0.1	1.6	2.3	**10.0**	0.7
Hyalella azteca	**8.4 ± 1.8**	0.3	0.5	1.2	0.8	**9.5**	0.6
Leptophlebidae	**8.5 ± 1.6**	0.3	0.2	1.2	2.9	1.2	6.0

Biocriteria data values are average percent ± standard deviation.

Table 9
Percent EPT, Dominant Macroinvertebrate Families, and Taxa at the Black Creek Test Stations during the Spring 2010 Sampling Season

Variable-Station	**Biocriteria Data**	**Black Cr #1**	**Black Ck #2**	**Black Ck #3**	**Black Cr #4**	**Black Cr #5**	**Black Cr #6**
EPT Metrics							
% EPT	27.5 ± 2.2	12.6	11.9	4.7	17.9	4.5	1.8
% Ephemeroptera	25.8 ± 2.1	11.7	10.6	4.1	17.4	3.8	1.1
% Plecoptera	1.1 ± 0.1	0	0	0	0	0	0
% Trichoptera	0.5 ± 0.0	0.9	1.3	0.5	0.4	0.7	0.7
Percent Dominant Families							
Chironomidae	**57.7 ± 2.3**	**66.6**	**70.1**	**74.1**	**61.5**	**72.6**	**79.3**
Caenidae	**22.1 ± 2.1**	**10.6**	**10.4**	**2.7**	**13.9**	**2.7**	0.3
Coenagrionidae	**4.4 ± 0.7**	1.5	2.6	0.2	1.6	0.5	0
Elmidae	**2.0 ± 0.2**	1.8	**2.8**	0.1	0	0	0
Baetidae	**1.4 ± 0.3**	0.4	0.1	0.1	0.2	0.2	0
Tubificidae	0.9 ± 0.1	**8.1**	**5.4**	**12.8**	**5.9**	**9.1**	**7.1**
Simuliidae	4.4 ± 0.7	**3.8**	1.6	0.4	0.5	1.3	0.7
Enchytraeidae	1.0 ± 0.1	**2.4**	0.3	1.4	0.6	0.1	**1.9**
Arachnoidea	0.5 ± 0.1	1.0	**3.1**	0.6	2.7	1.0	**1.6**
Crangonyctidae	0	0	0	**2.2**	1.4	0	**4.7**
Ceratopogonidae	0.5 ± 0.1	1.0	0.4	**1.6**	**4.6**	**3.8**	0.1
Heptageniidae	1.2 ± 0.2	0.7	0.1	1.1	3.3	0.7	0.1
Gammaridae	0	0	0	0	0	**3.0**	0
Percent Dominant Taxa							
Cricotopus/Orthocladius grp.	**23.6 ± 1.6**	**12.7**	5.3	**10.0**	5.2	**15.7**	**29.7**
Caenis latipennis	**22.1 ± 2.1**	**10.6**	**10.4**	2.7	**13.9**	2.7	0.3
Hydrobaenus	**11.9 ± 1.0**	0.4	0.6	0.4	0.6	0.5	3.8
Parakiefferiella	**5.5 ± 0.6**	1.0	**7.3**	4.3	**9.9**	**7.1**	**8.9**
Simulium	**4.2 ± 0.7**	3.8	1.6	0.4	0.5	1.3	0.7
Tanytarsus	3.6 ± 0.4	**15.0**	**11.6**	**10.9**	**9.5**	5.5	**9.1**
Dicrotendipes	2.4 ± 0.4	**8.0**	**7.6**	**9.5**	**10.6**	**13.3**	**7.8**
Tubificidae	0.6 ± 0.1	**7.0**	3.6	**8.7**	3.7	**6.2**	**5.3**
Polypedilum scalaenum	0.4 ± 0.1	3.5	**5.5**	**14.7**	1.3	2.2	2.1
Thienemannimyia group	1.4 ± 0.1	4.8	4.6	4.6	**5.7**	1.7	0.9
Glyptotendipes	2.2 ± 0.5	0.5	1.9	0.7	1.2	**5.8**	1.7

Biocriteria data values are average percent ± standard deviation.

3.3 Physicochemical Data

Water samples and field measurements were collected during the fall 2009 and spring 2010 macroinvertebrate sampling periods. Physicochemical results are arranged to demonstrate trends of certain variables that may identify a source for effects at the Black Creek test stations. Results can be found in Table 10 for the fall 2009 sampling season and Table 11 for the spring 2010 sampling season. Gray Branch station #1 was not sampled during the fall 2009 sampling season because water was only present in a few isolated pools. Results shown here are for stream discharge, dissolved oxygen, turbidity, nitrate + nitrite-N, total nitrogen, and total phosphorus by season.

3.3.1 Stream Discharge

Discharge was very low at the bioassessment sampling stations during the fall 2009 sampling season, ranging from <0.1 cfs at test station #6 to 1.6 cfs at test station #1. Discharge at the bioassessment sampling stations was much higher during the spring 2010 sampling season, ranging from 6.9 cfs at test station #5 to 24.3 cfs at test station #1.

3.3.2 Dissolved Oxygen

Dissolved oxygen was low at many of the sampling stations during the fall 2009 sampling season. Dissolved oxygen was below the water quality standard of 5 mg/L at Black Creek station #3, Black Creek station #7, and Pollard Branch #1 and slightly above the water quality standard at Black Creek stations #1, #4, and #5. Dissolved oxygen was much higher during the spring 2010 sampling season, ranging from 6.86 mg/L at Black Creek #5 to 11.11 mg/L at Gray Branch #1.

3.3.3 Turbidity

Turbidity was generally low during the fall 2009 sampling season, ranging from 6.34 NTU at Black Creek station #2 to 17.10 at Pollard Branch station #1. All of these values, except Pollard Branch station #1, were below the U.S. EPA recommended reference value of 15.5 NTU for the Level III Central Irregular Plains ecoregion (U.S. EPA 2000). Turbidity was much higher during the spring 2010 sampling season, ranging from 16.7 NTU at Pollard Branch station #1 to 31.5 NTU at Black Creek station #3. All spring 2010 values were above the U.S. EPA recommended value.

3.3.4 Nitrate + Nitrite-N

Nitrate + nitrite-N was low during the fall 2009 sampling season ranging from <0.05 to 0.10 mg/L. Values were much higher during the spring 2010 sampling season compared to fall, ranging from 0.26 mg/L at Black Creek station #6 to 0.41 mg/L at Black Creek stations #1 and #2. All of the spring 2010 values were above the U.S. EPA recommended value of 0.23 mg/L for the Level III Central Irregular Plains ecoregion.

Table 10
Physicochemical Variables at the Black Creek Bioassessment Study Sampling Stations, Fall 2009

	Black Creek #1	Black Creek #2	Black Creek #3	Black Creek #4	Black Creek #5	Black Creek #6	Black Creek #7	Pollard Br #1	Perry Br #1
Invertebrate Sample Number	0918433	0918434	0918435	0918436	0918437	0918438	-	-	-
Physicochemical Sample Number	0912076	0912077	0912078	0912079	0912080	0912081	0912083	0912082	0912084
Sample Date	09/15/09	09/15/09	09/15/09	09/16/09	09/16/09	09/16/09	09/16/09	09/16/09	09/16/09
Sample Time	1020	1255	1540	0930	1215	1420	1630	1150	1655
Ammonia	0.13	0.09	0.12	0.12	0.17	0.12	-	-	-
Chloride	6.38	6.53	10.80	9.60	10.2	9.08	-	-	-
Dissolved Oxygen	5.25	6.57	**4.22**	5.32	5.70	9.25	**3.52**	**1.75**	6.40
Discharge (cfs)	1.58	0.95	0.48	0.42	0.10	<0.05	<0.05	<0.05	<0.05
pH (Units)	7.80	7.80	7.60	7.60	7.60	7.70	7.70	7.60	7.70
Conductivity (µmhos/cm)	280	298	295	260	299	276	310	240	430
Temperature (°C)	19.5	21.3	20.0	19.3	23.1	23.3	21.0	19.0	20.0
Turbidity (NTU)	11.9	6.34	8.73	12.10	11.1	10.4	12.9	**17.1**	7.04
Total Suspended Solids	17.0	6.00	14.0	10.0	13.0	10.0	6.00	11.0	7.0
Nitrate + Nitrite	0.05*	0.05*	0.05*	0.05*	0.10	0.05*	-	-	-
Total Nitrogen	0.32	0.40	0.44	0.44	0.68	0.44	-	-	-
Total Phosphorus	0.05**	0.05**	0.07**	0.05**	0.07	**0.12**	-	-	-

*Below detectable limits
**Estimated value, detected below Practical Quantitation Limit
Units mg/L unless otherwise noted. Values in bold are elevated compared to water quality standards or U.S. EPA recommended reference condition values

Table 11
Physicochemical Variables at the Black Creek Bioassessment Study Sampling Stations, Spring 2010

	Black Creek #1	Black Creek #2	Black Creek #3	Black Creek #4	Black Creek #5	Black Creek #6	Black Creek #7	Pollard Br #1	Gray Br #1	Perry Br #1
Invertebrate Sample No.	1004052	1004051	1004053	1004054	1004055	1004056	-	-	-	-
Physicochemical Sample No.	1000877	1000878	1000879	1000880	1000881	1000882	1000885	1000883	1000884	1000886
Sample Date	04/13/10	04/13/10	04/13/10	04/13/10	04/13/10	04/13/10	04/13/10	04/13/10	04/13/10	04/13/10
Sample Time	1035	1305	0955	1140	0905	1040	1420	1315	1350	1445
Ammonia	0.28	0.30	0.38	0.40	0.42	0.39	-	-	-	-
Chloride	10.5	10.9	13.4	13.2	14.4	16.4	-	-	-	-
Dissolved Oxygen	8.60	10.42	7.56	8.12	6.86	8.20	9.14	8.95	11.11	11.09
Discharge (cfs)	24.26	17.98	13.48	8.42	6.22	4.30	1.77	1.05	0.29	1.27
pH (Units)	6.80	7.70	7.50	7.70	7.50	7.70	7.70	7.60	7.60	7.80
Conductivity (µmhos/cm)	280	288	315	313	317	353	380	368	395	365
Temperature (°C)	17.2	18.8	16.6	18.1	17.0	16.5	20.1	19.5	18.5	20.5
Turbidity (NTU)	**31.1**	**28.9**	**31.5**	**28.5**	**29.9**	**21.8**	**28.9**	**16.7**	**26.5**	**20.3**
Total Suspended Solids	5.00	10.0*	11.0	10.0	<5.0**	<5.0**	9.0	<5.0**	35.0	22.0
Nitrate + Nitrite	**0.41**	**0.41**	**0.37**	**0.35**	**0.31**	**0.26**	-	-	-	-
Total Nitrogen	**1.19**	**1.10**	**1.27**	**1.17**	**1.23**	**1.11**	-	-	-	-
Total Phosphorus	**0.14**	**0.12**	**0.17**	**0.16**	**0.18**	**0.16**	-	-	-	-

*Estimated value, QC data outside limits
**Below detectable limits
Units mg/L unless otherwise noted. Values in bold are elevated compared to U.S. EPA recommended reference condition values

3.3.5 Total Nitrogen

Total nitrogen was fairly low during the fall 2009 sampling season, ranging from 0.32 mg/L at Black Creek station #1 to 0.68 mg/L at Black Creek station #5. Values were much higher during the spring 2010 sampling season, ranging from 1.10 mg/L at Black Creek station #2 to 1.27 mg/L at Black Creek station #3. All of the spring 2010 values were above the U.S. EPA recommended value of 0.71 mg/L for the Level III Central Irregular Plains ecoregion.

3.3.6 Total Phosphorus

Total phosphorus was low compared to the U.S. EPA recommended reference condition value of 0.09 mg/L during the fall 2008 sampling season, except at Black Creek station #6. Total phosphorus ranged from 0.05 mg/L at Black Creek stations #1, #2, and #4 to 0.12 mg/L at Black Creek station #6. Total phosphorus was slightly higher during the spring 2010 sampling season, ranging from 0.12 mg/L at Black Creek station #2 to 0.18 mg/L at Black Creek station #5. All of the spring 2010 values were higher than the U.S. EPA recommended reference value.

4.0 Discussion

The discussion section describes possible effects of land use, geology, sedimentation, and physicochemical conditions on the macroinvertebrate community composition.

4.1 Possible Land Use and Geological Impacts

The MSCI results for Black Creek indicated that the macroinvertebrate community was not impaired and was comparable to the Central Plains/Cuivre/Salt EDU reference conditions for all of the sampling stations during the spring 2010 sampling season and four of the six sampling stations during the fall 2009 sampling season. There was, however, some evidence suggesting that the macroinvertebrate community structure was altered by the land use and geology of the watershed even though most of the Black Creek samples had MSCI scores in the fully supporting category. Specifically, the Black Creek macroinvertebrate community was generally made up of tolerant taxa and EPTT were low in abundance.

The dominant land use of the Black Creek watershed, especially the upper part, was cropland, ranging from 58 to 67 percent (Table 1). The high abundance of cropland in the watershed could be a contributing factor to high levels of sedimentation as shown in the stream habitat assessment (Table 2) and elevated values for some of the water quality parameters (Tables 10 and 11). The stream habitat assessment results showed that fine sediment covering the stream bottom made up at least 50 percent of the sampling reach at test stations #1, #2, #3, and #6, resulting in these stations scoring in the marginal or poor category for sediment deposition. Epifaunal substrate at all of the stations was generally low, with SHAPP scores either in the marginal or poor category for this metric. According to the SHAPP, epifaunal substrate ranks in the poor category when there is "less than 10 percent of a good mixture of substrate sizes" and in the marginal category when "10 to 30 percent of the stream bottom [is] made up of [a] good mixture of

substrate sizes." The elevated levels for nutrients and turbidity during the spring 2010 sampling season suggests that the high percentage of row crops in the watershed could be leading to surface runoff after rain events. The water levels at Black Creek during the spring 2010 sampling season were elevated from a recent rain event in the watershed.

There was some evidence that dissolved oxygen in Black Creek may be a problem during low flow periods. Dissolved oxygen was below the water quality standard of 5 mg/L during the fall 2009 sampling season at stations #3 and #7 and slightly above the standard at stations #1, #4, and #5 (Table 10). Possible causes of low dissolved oxygen conditions are geology and stream type that, during low flow conditions, could cause water stagnation and increased water temperatures. Land use also could influence dissolved oxygen levels with the possibility of increased runoff and reduced shading of the riparian zone due to the high amount of row crops in the watershed. Black Creek is very similar to the description by Sowa and Diamond (2006) for the eastern part of the Lick Creek AES type in which streams are prairie-like to transitional with stream channels made up of sand, silt, and clay that are meandering, low gradient systems with narrow watersheds. Many of the Black Creek stations had high levels of sedimentation and organic material primarily made up of woody debris. The combination of stream type, sedimentation, organic woody debris material, low flow conditions, and the high percentage of row crops in the watershed could lead to low dissolved oxygen conditions.

4.2 MSCI and Macroinvertebrate Community Structure

Macroinvertebrate samples from Black Creek stations #3 and #6 during the fall 2009 sampling season were the only samples that had MSCI scores in the partially supporting category during the study. Based on the results of the two sampling seasons, test station #3 had a macroinvertebrate community that was borderline between being partially and fully supporting with an MSCI score of 12 in fall 2009 and 16 in the spring 2010 sampling season. The two metrics that led to lower MSCI scores and showed possible impairment at the station were biotic index and EPTT. Biotic index was much higher than biological criteria for both sampling seasons and EPTT was much lower than biological criteria in fall 2009 and slightly lower during the spring 2010 sampling season. The five most abundant taxa found in the fall 2009 Black Creek station #3 sample ranged in tolerance from the slightly tolerant *Tanytarsus*, with a biotic index value of 6.7, to the very tolerant *Argia*, which had a biotic index value of 8.7 (Table 8). During the spring 2010 sampling season, the five most abundant taxa ranged in tolerance from the slightly tolerant *Tanytarsus*, with a biotic index value of 6.7, to the very tolerant tubificid worms with a biotic index value of 9.2 (Table 9). The only common EPT taxa found during the fall 2009 sampling season in the Black Creek #3 samples were two tolerant mayflies, *Caenis latipennis* and *Stenacron*, and *Caenis latipennis* during the spring 2010 sampling season. Possible sources contributing to the tolerant macroinvertebrate community and resultant low MSCI score at test station #3 included stream habitat conditions, low dissolved oxygen, and possible influence of the Shelbyville WWTF, which discharges into Black Creek 2.3 miles upstream. The sampling reach had very poor epifaunal

substrate, fairly high sediment deposition, large amounts of organic woody debris, and low dissolved oxygen during the fall 2009 sampling season.

As was the case for Black Creek station #3, results at Black Creek station #6 were inconclusive due to an MSCI score of 14 during fall 2009 and 18 during the spring 2010 sampling season. The values for three metrics, TR, EPTT, and BI, were in the partially supporting range, leading to an MSCI score of 14 during the fall 2009 sampling season. Taxa richness was slightly lower, EPTT was much lower, and biotic index was much higher than biological criteria. The five most abundant taxa found in the Black Creek station #6 fall 2009 sample ranged in tolerance from the slightly tolerant *Tribelos* (with a biotic index of 6.6) and *Tanytarsus* (with a biotic index value of 6.7) to the very tolerant *Glyptotendipes*, with a biotic index value of 8.7 (Table 8). During the spring 2010 sampling season, the five most abundant taxa ranged in tolerance from the slightly tolerant *Cricotopus/Orthocladius* group (with a biotic index value of 6.5) to the very tolerant tubificid worms, with a biotic index value of 9.2 (Table 9). Leptophlebiid mayflies were the only common EPTT taxa found in Black Creek station #6 during the fall 2009 sampling season. During the spring 2010 sampling season, EPTT only made up 1.8 percent of the sample and leptophlebiid mayflies, *Caenis latipennis*, and *Stenacron* were found in very low abundances. Possible contributors of the low MSCI score and tolerant macroinvertebrate community at Black Creek station #6 during the fall 2009 sampling season included stream habitat conditions and small stream size. The overall habitat score at Black Creek station #6 was fairly low compared to reference conditions (Table 3). Black Creek station #6 had an overall stream habitat score of 100 which was 75.2 percent of the North River biological criteria reference station stream habitat score. Black Creek station #6 had marginal quality scores for pool variability, sediment deposition, channel flow status, and left bank stability and poor quality scores for epifaunal substrate, vegetative protection of banks, and right bank riparian zone. Black Creek station #6 was smaller with a much narrower channel than the remaining sample stations (Table 4).

The other test stations had MSCI scores of 16 during the fall 2009 sampling season and generally had similar values for the four biological metrics that make up the MSCI. The sampling stations had values in the fully supporting range for TR and SDI and in the partially supporting range for EPTT and biotic index. These stations, like Black Creek stations #3 and #6, had much higher biotic index values and lower EPTT taxa values than biological criteria reference conditions. Most of the taxa common in these samples, such as *Dicrotendipes*, *Glyptotendipes*, *Argia*, and *Caenis latipennis*, had biotic index values greater than 7.5. *Tanytarsus*, with a slightly tolerant biotic index value of 6.7, was common in all of the samples. The only common EPTT taxa found in the samples were the mayflies *Caenis latipennis*, *Stenacron*, and Leptophlebidae. During the spring 2010 sampling season, Black Creek stations #1 and #5 had MSCI scores of 18 and stations #2 and #4 had scores of 20. These stations had macroinvertebrate communities that were similar to or slightly less tolerant than biological reference conditions, but were made up of a lower proportion of EPT taxa compared to reference conditions. Macroinvertebrates

that were common in these samples ranged from slightly tolerant taxa such as *Cricotopus/Orthocladius* group (biotic index of 6.5) and *Tanytarsus* (biotic index of 6.7) to more tolerant taxa such as *Dicrotendipes* (biotic index of 7.9), *Polypedilum scalaenum* group (biotic index of 8.7), and tubificid worms (biotic index of 9.2). The mayfly *Caenis latipennis* was the only common EPTT found in the samples.

5.0 Conclusions

MSCI scores were in the partially supporting range at Black Creek stations #3 and #6 and in the fully supporting range at the remaining test stations during the fall 2009 sampling season. During the spring 2010 sampling season, all test stations scored in the fully supporting range. The MSCI results at test stations #3 and #6 during the fall 2009 sampling season led to the rejection of the first two null hypotheses. The first null hypothesis stated that the macroinvertebrate community will not differ among longitudinally separate reaches of Black Creek. The second null hypothesis stated that the macroinvertebrate community in Black Creek will not differ from the glide/pool biological criteria for the Central Plains/Cuivre/Salt EDU.

The stream habitat assessment results indicated that Black Creek station #1 was habitat limited since its overall habitat score of 93 was lower than the 75 percent value of the North River biological criteria reference station habitat score of 133. This result led to the rejection of the third and fourth null hypotheses of this study. The third hypothesis stated that the stream habitat assessment scores will not differ among longitudinally separate reaches of Black Creek. The fourth hypothesis stated that the stream habitat assessment scores in Black Creek will not differ from North River, a glide/pool biological criteria reference stream in the Central Plains/Cuivre/Salt EDU.

Dissolved oxygen was below the Missouri water quality standard of 5 mg/L at Black Creek stations #3 and #7 and slightly above at stations #1, #4, and #5 during the 2009 sampling season. This result led to the rejection of the fifth and sixth null hypotheses. The fifth hypothesis stated that the physicochemical water quality in Black Creek will meet the Water Quality Standards (**WQS**) of Missouri (MDNR 2010a). The sixth hypothesis stated that the physicochemical water quality will not differ among longitudinally separate reaches of Black Creek. Nitrate + nitrite-N, total nitrogen, total phosphorus, and turbidity were elevated compared to U.S. EPA recommended reference condition values at all of the test stations during the spring 2010 sampling season. These results were possibly caused by surface runoff since the spring 2010 samples were collected during higher flows caused by a recent rain event.

Possible sources of impairment of Black Creek #3 during the fall 2009 sampling season include low dissolved oxygen, stream type caused by local geology, sedimentation, and poor epifaunal substrate. Possible sources of the low MSCI score at Black Creek #6 during the fall 2009 sampling season include stream habitat conditions and small stream size. The overall habitat score of 100 at test station #6 was 75.2 percent of the North River biological criteria reference station score of 133. Black Creek station #6 had

marginal habitat quality scores for pool variability, sediment deposition, channel flow status, and left bank stability and poor habitat quality scores for epifaunal substrate, vegetative protection of banks, and right bank riparian zone. Test station #6 was also smaller, with a much narrower channel than the other Black Creek sampling stations, which could have led to less available habitat for macroinvertebrates to inhabit.

6.0 References Cited

Missouri Department of Natural Resources. 2002. Biological Criteria for Wadeable/Perennial Streams of Missouri. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 32 pp.

Missouri Department of Natural Resources. 2009. Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 27 pp.

Missouri Department of Natural Resources. 2010a. Title 10. Rules of Department of Natural Resources Division 20-Clean Water Commission, Chapter 7-Water Quality. 10 CSR 20-7.031 Water Quality Standards. pp. 10-136.

Missouri Department of Natural Resources. 2010b. Stream Habitat Assessment Project Procedure. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri. 40 pp.

Missouri Department of Natural Resources. 2010c. Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 26 pp.

Missouri Department of Natural Resources. 2010d. Field Sheet and Chain of Custody Record. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 14 pp.

Missouri Department of Natural Resources. 2010e. Flow Measurements in Open Channels. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 12 pp.

Sowa, S.P., D.D. Diamond, R.A. Abbitt, G.M. Annis, T. Gordon, M.E. Morey, G.R. Sorensen, and D. True. 2004. Final Report of The Aquatic Component of GAP Analysis: A Missouri Prototype. Missouri Resource Assessment Partnership (MoRAP), University of Missouri. 111 pp.

Sowa, S., and D. Diamond. 2006. Using GIS and an Aquatic Ecological Classification System to Classify and Map Distinct Riverine Ecosystems Throughout EPA Region 7. Missouri Resource Assessment Partnership (MoRAP), University of Missouri. 242 pp.

United States Environmental Protection Agency. 2000. Ambient Water Quality Criteria Recommendations. Information Supporting the Development of State and Tribal Nutrient Criteria for River and Streams in Nutrient Ecoregion IX. United States Environmental Protection Agency, Office of Water, Washington, D.C., EPA-822-B-00-019. 32 pp.

Submitted by: _____

Carl Wakefield
Environmental Specialist
Water Quality Monitoring Section
Environmental Services Program

Date: _____

Approved by: _____

Alan Reinkemeyer
Director
Environmental Services Program

AR:cwt

c: John Ford, QAPP Project Manager, WPP

Appendix A

Black Creek Macroinvertebrate Taxa Lists

Aquid Invertebrate Database Bench Sheet Report
Black Cr [0918433], Station #1, Sample Date: 9/15/2009 10:45:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	9	2	1
AMPHIPODA			
Hyalella azteca		3	
ARHYNCHOBDELLIDA			
Erpobdellidae		-99	
COLEOPTERA			
Berosus		1	
Dubiraphia	6	8	
Stenelmis	3	7	3
DIPTERA			
Ablabesmyia	10	18	13
Anopheles		3	
Ceratopogonidae	1		
Chironomidae			4
Chironomus	1		
Cladotanytarsus	10	2	1
Cryptochironomus	8		
Cryptotendipes	6		
Dicrotendipes	37	8	62
Glyptotendipes		11	31
Harnischia	1		
Labrundinia		2	6
Microtendipes		1	
Nanocladius	2	17	3
Parachironomus		4	
Paracladopelma	1		
Paralauterborniella	5		1
Paratanytarsus	5	16	5
Phaenopsectra	1		
Polypedilum fallax grp			2
Polypedilum halterale grp	61		
Polypedilum illinoense grp		2	3
Polypedilum scalaenum grp	8		3
Procladius	8	1	
Pseudochironomus			2
Rheotanytarsus			9
Stelechomyia			2
Stempellina	1		
Stempellinella	1		

Aquid Invertebrate Database Bench Sheet Report
Black Cr [0918433], Station #1, Sample Date: 9/15/2009 10:45:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Stenochironomus			15
Tabanus	1		
Tanytarsus	37	35	56
Thienemanniella			2
Thienemannimyia grp.	1	22	18
Tribelos		1	17
EPHEMEROPTERA			
Caenis latipennis	47	19	5
Heptageniidae	2	1	1
Hexagenia limbata	1		
Leptophlebiidae		2	1
Procloeon	25	1	2
Stenacron	1		6
HEMIPTERA			
Corixidae	3		
LIMNOPHILA			
Ancylidae		4	
Menetus		12	
Physella		2	
ODONATA			
Argia	5	67	3
Dromogomphus	-99		
Macromia		-99	
TRICHOPTERA			
Cheumatopsyche			2
Oecetis	1		
TRICLADIDA			
Planariidae		4	
TUBIFICIDA			
Enchytraeidae			2
Tubificidae	1	4	1
VENEROIDA			
Pisidiidae		7	1

Aquid Invertebrate Database Bench Sheet Report
Black Cr [0918434], Station #2, Sample Date: 9/15/2009 1:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	4	4	2
AMPHIPODA			
Hyalella azteca		5	
ARHYNCHOBDELLIDA			
Erpobdellidae	2		
BRANCHIOBDELLIDA			
Branchiobdellida	1		
COLEOPTERA			
Berosus		1	
Dubiraphia	7	15	1
Scirtidae		1	
Stenelmis	6	5	3
DIPTERA			
Ablabesmyia	18	4	11
Anopheles		1	1
Chaoborus			1
Chironomidae	5	1	4
Chironomus	2		2
Cladotanytarsus	5		2
Cricotopus bicinctus	1		
Cryptochironomus	11		4
Cryptotendipes	1		
Dicrotendipes	24	26	99
Forcipomyiinae			1
Glyptotendipes	2	19	11
Harnischia	1		
Labrundinia	1		
Microtendipes		1	5
Nanocladius	1	10	1
Nilothauma	2		
Parachironomus		5	
Paracladopelma	1		
Paralauterborniella	6	1	2
Paratanytarsus	3	26	3
Phaenopsectra	2	1	1
Polypedilum halterale grp	3		1
Polypedilum illinoense grp	3	1	
Polypedilum scalaenum grp	2		2
Procladius	14	2	2

Aquid Invertebrate Database Bench Sheet Report
Black Cr [0918434], Station #2, Sample Date: 9/15/2009 1:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Pseudochironomus			2
Rheotanytarsus	5		
Stempellinella	2		2
Stenochironomus	4		7
Tanytarsus	27	38	45
Thienemannimyia grp.	5	11	7
Tribelos	5	2	15
EPHEMEROPTERA			
Caenis latipennis	107	20	19
Hexagenia limbata	2		
Leptophlebiidae		1	1
Procloeon	4		3
Stenacron	7	3	4
HEMIPTERA			
Corixidae	1		
Microvelia		1	
Neoplea		1	
LIMNOPHILA			
Ancylidae		1	1
Menetus	1	18	
Physella		1	1
ODONATA			
Argia	1	82	7
Calopteryx	-99		
Gomphidae		1	
Macromia		-99	
TRICHOPTERA			
Cheumatopsyche	1		1
Nectopsyche		2	
Oecetis	1	2	
Triaenodes		1	
TRICLADIDA			
Planariidae		1	
TUBIFICIDA			
Aulodrilus	5		
Limnodrilus cervix	4		
Tubificidae	93	5	

Aquid Invertebrate Database Bench Sheet Report
Black Cr [0918435], Station #3, Sample Date: 9/15/2009 4:10:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	44		
AMPHIPODA			
Hyalella azteca		9	2
ARHYNCHOBDELLIDA			
Erpobdellidae	1	-99	3
COLEOPTERA			
Scirtidae	5	2	
DIPTERA			
Ablabesmyia	15	8	15
Ceratopogoninae	5		1
Chironomidae		2	4
Chironomus	6	1	1
Cladotanytarsus	7		1
Corynoneura	1		
Cricotopus bicinctus	1		
Cryptochironomus	8		1
Cryptotendipes	4		
Dicrotendipes	6	4	55
Glyptotendipes	5	69	51
Harnischia	1		
Labrundinia	4	3	2
Nanocladius		2	
Parachironomus	1	1	
Paralauterborniella	6	1	6
Paratanytarsus	5	31	2
Phaenopsectra	3	1	
Polypedilum fallax grp		1	4
Polypedilum halterale grp	2		
Polypedilum illinoense grp	7	6	
Polypedilum scalaenum grp	8		6
Procladius	9	1	
Stempellinella	1		
Stenochironomus	1		1
Tanytarsus	15	23	61
Thienemanniella	1		
Thienemannimyia grp.		30	14
Tribelos	9	6	13
EPHEMEROPTERA			
Caenis latipennis	31	11	4

Aquid Invertebrate Database Bench Sheet Report
Black Cr [0918435], Station #3, Sample Date: 9/15/2009 4:10:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Leptophlebiidae		9	2
Procloeon	4		
Stenacron	46	9	5
HEMIPTERA			
Corixidae	15		
Microvelia		4	
Ranatra		-99	
LIMNOPHILA			
Ancylidae	1		2
Menetus		27	1
Physella		3	
LUMBRICULIDA			
Lumbriculidae		2	
ODONATA			
Argia	7	73	4
Enallagma		1	1
Libellula		-99	
Libellulidae	2		
Nasiaeschna pentacantha		1	
RHYNCHOBDELLIDA			
Glossiphoniidae		2	
TRICLADIDA			
Planariidae		13	
TUBIFICIDA			
Aulodrilus		1	
Ilyodrilus templetoni	1		
Tubificidae	23	6	3
UNIONIDA			
Unionidae	1		
VENEROIDA			
Pisidiidae	1	3	

Aquid Invertebrate Database Bench Sheet Report
Black Cr [0918436], Station #4, Sample Date: 9/16/2009 10:00:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	43	6	4
AMPHIPODA			
Hyalella azteca		1	7
ARHYNCHOBDELLIDA			
Erpobdellidae	-99	1	-99
COLEOPTERA			
Dubiraphia		1	
Peltodytes		1	
Scirtidae			1
DIPTERA			
Ablabesmyia	21	17	7
Anopheles			1
Ceratopogoninae		1	1
Chironomidae	2	8	
Chironomus	9		1
Cladotanytarsus	12		3
Cricotopus/Orthocladius		1	
Cryptochironomus	7		
Cryptotendipes	7		
Dicrotendipes	4	15	82
Diptera	1		
Glyptotendipes	1	27	33
Labrundinia	1	3	3
Microtendipes	1	2	
Nilothauma		1	
Parachironomus		3	
Parakiefferiella			1
Paralauterborniella	2		
Paratanytarsus	8	13	9
Phaenopsectra	7	1	2
Polypedilum fallax grp		1	8
Polypedilum halterale grp	10		
Polypedilum illinoense grp	3	1	1
Polypedilum scalaenum grp	1		3
Procladius	6	1	2
Pseudochironomus			4
Stempellinella	1		
Stenochironomus	1	1	33
Tanytarsus	29	24	35

Aquid Invertebrate Database Bench Sheet Report
Black Cr [0918436], Station #4, Sample Date: 9/16/2009 10:00:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Thienemannimyia grp.	2	32	30
Tribelos	20	16	12
Xenochironomus		1	
EPHEMEROPTERA			
Caenis latipennis	34	24	9
Hexagenia limbata	2		
Leptophlebiidae	1	27	
Procloeon		1	1
Stenacron	5	1	20
HEMIPTERA			
Belostoma		-99	
Corixidae	19		4
Palmacorixa	-99		
Trichocorixa	1		
LIMNOPHILA			
Ancylidae	2	2	
Menetus	2	17	
Physella	3	10	1
MESOGASTROPODA			
Hydrobiidae		2	1
ODONATA			
Argia	6	33	8
Enallagma	1	24	
Gomphidae	1	-99	
Macromia		1	
RHYNCHOBDELLIDA			
Glossiphoniidae	-99	4	
TRICHOPTERA			
Cheumatopsyche		2	
Nectopsyche		1	
Oecetis	2	2	
Triaenodes		5	
TUBIFICIDA			
Aulodrilus		1	
Limnodrilus hoffmeisteri	2		
Tubificidae	29	5	1
VENEROIDA			
Pisidiidae	1	4	

Aquid Invertebrate Database Bench Sheet Report
Black Cr [0918437], Station #5, Sample Date: 9/16/2009 12:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	27	4	4
AMPHIPODA			
Hyalella azteca	2	66	20
ARHYNCHOBDELLIDA			
Erpobdellidae	1	-99	-99
COLEOPTERA			
Helichus lithophilus			1
Scirtidae		3	
DIPTERA			
Ablabesmyia	8		11
Anopheles			1
Axarus	8		
Ceratopogoninae	10	1	1
Chaoborus	3		
Chironomidae	2	1	1
Chironomus	33		2
Cladotanytarsus	3		
Cricotopus bicinctus			2
Cricotopus/Orthocladius		1	
Cryptochironomus	5		
Cryptotendipes	3		
Dicrotendipes	5	4	99
Diptera			1
Forcipomyiinae			1
Glyptotendipes	5	31	89
Harnischia	1		
Labrundinia		1	2
Microtendipes			1
Nanocladius			1
Parachironomus		9	
Paralauterborniella	1		
Paratanytarsus	1	10	9
Phaenopsectra		1	
Polypedilum halterale grp	1		
Polypedilum illinoense grp	1	4	6
Polypedilum scalaenum grp		1	1
Procladius	20		3
Stenochironomus		1	10
Stictochironomus	1		

Aquid Invertebrate Database Bench Sheet Report
Black Cr [0918437], Station #5, Sample Date: 9/16/2009 12:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Tanytarsus	12	20	34
Thienemannimyia grp.		8	18
Tribelos	1	3	5
EPHEMEROPTERA			
Caenis latipennis	10	17	9
Hexagenia limbata	3		
Leptophlebiidae	1	8	2
Stenacron	4	4	16
HEMIPTERA			
Corixidae	90		2
Trichocorixa			1
LIMNOPHILA			
Ancylidae	1		
Helisoma			-99
Menetus		4	5
Physella		11	1
MESOGASTROPODA			
Hydrobiidae		1	
ODONATA			
Argia	1	11	2
Enallagma		9	
Libellula	1		
Macromia		-99	
RHYNCHOBDELLIDA			
Glossiphoniidae		3	
TRICHOPTERA			
Oecetis	3		
TRICLADIDA			
Planariidae		14	
TUBIFICIDA			
Aulodrilus	4		
Enchytraeidae		1	
Ilyodrilus templetoni	2		
Tubificidae	33		1
VENEROIDA			
Pisidiidae	1	-99	1

Aquid Invertebrate Database Bench Sheet Report
Black Cr [0918438], Station #6, Sample Date: 9/16/2009 2:45:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	22	1	4
AMPHIPODA			
Hyalella azteca		6	
ARHYNCHOBDELLIDA			
Erpobdellidae	-99	1	-99
COLEOPTERA			
Scirtidae	1	1	
DIPTERA			
Ablabesmyia	17	8	17
Axarus	2		
Ceratopogoninae			1
Chironomidae	2	1	1
Chironomus	34		4
Cladotanytarsus	1		
Corynoneura			1
Cryptochironomus	4		
Cryptotendipes	2		
Dicrotendipes	8	3	86
Glyptotendipes	8	36	82
Harnischia	1		
Kiefferulus			1
Labrundinia		6	6
Microtendipes	1		1
Nanocladius		3	2
Parachironomus		2	
Paraphaenocladius			2
Paratanytarsus	14	39	9
Phaenopsectra	1	4	2
Polypedilum fallax grp	2		6
Polypedilum halterale grp	8		1
Polypedilum illinoense grp	2	1	9
Polypedilum scalaenum grp	1		
Procladius	2		
Rheotanytarsus			2
Stempellinella	2		
Stenochironomus	2		14
Tanytarsus	43	26	63
Thienemannimyia grp.		3	5
Tribelos	56	5	6

Aquid Invertebrate Database Bench Sheet Report
Black Cr [0918438], Station #6, Sample Date: 9/16/2009 2:45:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Xenochironomus		1	
EPHEMEROPTERA			
Caenis latipennis	1	3	
Leptophlebiidae	7	45	7
Stenacron	2	11	7
HEMIPTERA			
Corixidae	6		1
Microvelia		2	
LEPIDOPTERA			
Crambidae	-99		
LIMNOPHILA			
Ancylidae	1	5	8
Lymnaeidae		1	
Menetus	1	37	1
Physella	5	42	4
ODONATA			
Argia	1	4	
Enallagma		2	
Ischnura	1	1	
RHYNCHOBDELLIDA			
Piscicolidae		1	
TRICHOPTERA			
Cheumatopsyche	1		3
Oecetis		1	
Triaenodes		3	
TRICLADIDA			
Planariidae		7	
TUBIFICIDA			
Tubificidae	42	2	7
VENEROIDA			
Pisidiidae			2

Aquid Invertebrate Database Bench Sheet Report
Black Cr [1004052], Station #1, Sample Date: 4/13/2010 12:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	2	3	4
AMPHIPODA			
Hyalella azteca		2	
COLEOPTERA			
Dubiraphia	3	11	
Hydrochus		1	
Neoporus		1	
Peltodytes		1	
Scirtidae		1	
Stenelmis		2	
DECAPODA			
Orconectes virilis		-99	
DIPTERA			
Ablabesmyia		6	1
Ceratopogoninae	1	3	5
Chironomidae	1	15	32
Chironomus		2	
Cladotanytarsus	5	1	8
Cricotopus/Orthocladius	2	29	85
Cryptochironomus	8		1
Cryptotendipes	2		
Dicrotendipes	3	7	63
Eukiefferiella		1	3
Glyptotendipes		1	4
Hydrobaenus	1	2	1
Labrundinia		1	
Microtendipes	1	1	
Nilothauma			1
Paracladopelma	7		
Parakiefferiella	2	7	
Paralauterborniella	14	2	
Paratanytarsus		10	
Phaenopsectra	1	2	3
Polypedilum convictum		2	21
Polypedilum fallax grp		1	6
Polypedilum halterale grp	3		
Polypedilum illinoense grp	2	1	1
Polypedilum scalaenum grp	12	2	18
Pseudosmittia			2

Aquid Invertebrate Database Bench Sheet Report
Black Cr [1004052], Station #1, Sample Date: 4/13/2010 12:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Rheotanytarsus	2	1	8
Simulium	1	1	33
Stempellina	1		
Stenochironomus	1		4
Tanytarsus	16	78	43
Thienemannimyia grp.	1	37	6
Tipula		-99	
Tribelos		3	
EPHEMEROPTERA			
Acentrella			2
Caenis latipennis	17	77	3
Procloeon		2	
Stenacron		6	
LIMNOPHILA			
Physella		3	
ODONATA			
Argia		8	
Enallagma	1	3	
Gomphidae	1		
Ischnura		2	
TRICHOPTERA			
Cheumatopsyche	1	2	2
Ironoquia		2	
Nectopsyche		1	
TUBIFICIDA			
Aulodrilus	4		
Enchytraeidae	14	5	3
Limnodrilus hoffmeisteri	5	1	
Tubificidae	62	2	
VENEROIDA			
Pisidiidae		1	

Aquid Invertebrate Database Bench Sheet Report
Black Cr [1004051], Station #2, Sample Date: 4/13/2010 2:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	27	4	1
AMPHIPODA			
Hyalella azteca		3	
COLEOPTERA			
Dubiraphia	3	14	
Peltodytes	5		
Stenelmis	4	7	1
DECAPODA			
Orconectes virilis		-99	
DIPTERA			
Ablabesmyia	2	11	
Ceratopogoninae	1	2	1
Chironomidae	17	11	6
Chironomus	4	4	
Cladotanytarsus	36		6
Cricotopus/Orthocladius	2	21	31
Cryptochironomus	5		1
Cryptotendipes	11		
Dicrotendipes	12	7	59
Diptera	7		
Eukiefferiella	1		1
Glyptotendipes	3	4	13
Hydrobaenus		3	3
Labrundinia		1	
Larsia		1	
Micropsectra		2	
Nanocladius		5	
Nilothauma			1
Paracladopelma	1		
Parakiefferiella	4	67	4
Paralauterborniella	9	3	1
Paratanytarsus	3	5	
Phaenopsectra	3	2	2
Polypedilum convictum			19
Polypedilum fallax grp	1		13
Polypedilum halterale grp	12		2
Polypedilum illinoense grp			5
Polypedilum scalaenum grp	22		34
Pseudochironomus			1

Aquid Invertebrate Database Bench Sheet Report
Black Cr [1004051], Station #2, Sample Date: 4/13/2010 2:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Pseudosmittia			28
Rheotanytarsus	1	4	4
Simulium	4	1	11
Stenochironomus	3	1	6
Stictochironomus	1	1	
Tanytarsus	11	66	42
Thienemanniella		1	
Thienemannimyia grp.	3	31	13
Tribelos		1	2
Zavrelimyia		4	
EPHEMEROPTERA			
Caenis latipennis	65	40	2
Centroptilum	1		
Stenacron	1		
ODONATA			
Argia	2	9	8
Calopteryx		-99	
Enallagma		8	
Gomphus		-99	
Macromia		-99	
Progomphus obscurus	1		
RHYNCHOBDELLIDA			
Glossiphoniidae	1		
TRICHOPTERA			
Cheumatopsyche		2	3
Hydroptila			1
Nectopsyche		1	
Oecetis	2	1	1
Triaenodes		2	
TUBIFICIDA			
Aulodrilus	3		
Enchytraeidae			3
Limnodrilus cervix	7		
Limnodrilus hoffmeisteri	6	2	
Tubificidae	36		1
VENEROIDA			
Pisidiidae	1	1	

Aquid Invertebrate Database Bench Sheet Report
Black Cr [1004053], Station #3, Sample Date: 4/13/2010 10:10:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	2	5	
AMPHIPODA			
Crangonyx		25	
Hyalella azteca		6	
ARHYNCHOBDELLIDA			
Erpobdellidae	1	-99	
COLEOPTERA			
Dubiraphia		1	
Neoporus	1	1	
DECAPODA			
Orconectes		-99	
DIPTERA			
Ablabesmyia	1	14	
Ceratopogoninae	6	8	4
Chaoborus	2		
Chironomidae	21	15	11
Chironomus	7	2	
Cladotanytarsus	10	1	
Cricotopus/Orthocladius	13	27	72
Cryptochironomus	4		1
Cryptotendipes	19	2	3
Dicrotendipes	4	12	90
Endochironomus		2	
Eukiefferiella			1
Glyptotendipes			8
Hydrobaenus	1	4	
Nanocladius			1
Parachironomus	2		
Paracladopelma	1		
Parakiefferiella	3	41	4
Paralauterborniella	17	1	3
Paratanytarsus	1	12	1
Phaenopsectra		6	3
Polypedilum convictum	1		7
Polypedilum fallax grp			5
Polypedilum halterale grp	10	1	1
Polypedilum illinoense grp	1	2	
Polypedilum scalaenum grp	100		64
Rheocricotopus			2

Aquid Invertebrate Database Bench Sheet Report
Black Cr [1004053], Station #3, Sample Date: 4/13/2010 10:10:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Rheotanytarsus		2	8
Simulium		1	3
Stenochironomus			6
Tanytarsus	29	53	40
Thienemanniella	1		
Thienemannimyia grp.	6	25	20
Tribelos	1		
Zavrelimyia		1	
EPHEMEROPTERA			
Acentrella			1
Caenis latipennis	3	26	1
Leptophlebiidae		2	1
Stenacron	1	2	9
HEMIPTERA			
Corixidae	1		
ISOPODA			
Caecidotea	2	2	1
LIMNOPHILA			
Physella		1	
LUMBRICINA			
Lumbricina		1	
ODONATA			
Argia		2	
TRICHOPTERA			
Cheumatopsyche	4		
Ironoquia		1	
Oecetis		1	
TUBIFICIDA			
Enchytraeidae	2	10	4
Limnodrilus claparedianus	2		
Limnodrilus hoffmeisteri	22	20	2
Tubificidae	66	28	3
VENEROIDA			
Pisidiidae	1	1	

Aquid Invertebrate Database Bench Sheet Report
Black Cr [1004054], Station #4, Sample Date: 4/13/2010 12:00:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	20	9	1
AMPHIPODA			
Crangonyx	12	3	
Hyalella azteca		1	
ARHYNCHOBDELLIDA			
Erpobdellidae	-99	-99	
COLEOPTERA			
Dytiscidae		1	
Peltodytes	1		
DECAPODA			
Orconectes virilis		-99	
DIPTERA			
Ablabesmyia	3	8	
Ceratopogoninae	41	7	2
Chironomidae	6	17	26
Chironomus	2	2	1
Chrysops	1		
Cladotanytarsus	11	1	3
Cricotopus/Orthocladius	7	19	31
Cryptochironomus	5	1	2
Cryptotendipes	19	1	1
Dicrotendipes	7	24	85
Glyptotendipes	4	4	5
Hydrobaenus	2	2	3
Labrundinia	2		
Microtendipes	1		1
Paracladopelma	1		
Parakiefferiella	10	60	38
Paralauterborniella	10		
Paratanytarsus		9	2
Phaenopsectra	2	1	1
Polypedilum aviceps	2	1	1
Polypedilum fallax grp	1	3	4
Polypedilum halterale grp	5		1
Polypedilum scalaenum grp	1		13
Pseudosmittia			1
Rheocricotopus			3
Rheotanytarsus		3	1
Simulium	3	1	1

Aquid Invertebrate Database Bench Sheet Report
Black Cr [1004054], Station #4, Sample Date: 4/13/2010 12:00:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Stenochironomus		1	25
Tanytarsus	23	53	28
Thienemannimyia grp.	4	23	35
EPHEMEROPTERA			
Acentrella		1	
Acerpenna		1	
Caenis latipennis	69	58	25
Leptophlebiidae	1		
Stenacron	13	15	8
HEMIPTERA			
Trichocorixa	1		
LIMNOPHILA			
Lymnaeidae	3		3
Menetus		1	
Physella		1	-99
MESOGASTROPODA			
Hydrobiidae		11	5
ODONATA			
Argia	1	7	
Basiaeschna janata		-99	
Dromogomphus	2		
Enallagma	3	4	2
Ischnura			1
Macromia		-99	
Somatochlora		-99	
RHYNCHOBDELLIDA			
Piscicolidae	1	1	
TRICHOPTERA			
Cheumatopsyche		1	2
Nectopsyche		1	
Triaenodes		-99	
TUBIFICIDA			
Enchytraeidae	2	5	
Limnodrilus hoffmeisteri	12	3	9
Tubificidae	22	8	10
UNIONIDA			
Unionidae	1		
VENEROIDA			
Pisidiidae	1	-99	1

Aquid Invertebrate Database Bench Sheet Report
Black Cr [1004055], Station #5, Sample Date: 4/13/2010 9:30:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	8	2	
AMPHIPODA			
Gammarus	4	25	2
Hyalella azteca		8	
ARHYNCHOBDELLIDA			
Erpobdellidae	1	-99	-99
COLEOPTERA			
Dytiscidae		1	
DECAPODA			
Orconectes immunis		-99	
DIPTERA			
Ablabesmyia	1	6	
Ceratopogoninae	38		2
Chironomidae	10	16	16
Chironomus		5	
Cladotanytarsus	15		
Cricotopus/Orthocladius	5	116	43
Cryptochironomus	6		2
Cryptotendipes	47		1
Dicrotendipes	19	6	114
Endochironomus			1
Glyptotendipes	3	1	56
Hemerodromia			2
Hydrobaenus		4	1
Paracladopelma	4		
Parakiefferiella	5	43	26
Paralauterborniella	16		
Paratanytarsus	1	3	1
Phaenopsectra	1	2	2
Polypedilum convictum		1	19
Polypedilum fallax grp	1		5
Polypedilum halterale grp	2		
Polypedilum scalaenum grp	10		13
Procladius	2		
Pseudochironomus	1		
Pseudosmittia			1
Rheotanytarsus			1
Simulium	1		13
Stenochironomus			24

Aquid Invertebrate Database Bench Sheet Report
Black Cr [1004055], Station #5, Sample Date: 4/13/2010 9:30:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Tanytarsus	17	20	20
Thienemannimyia grp.		2	16
Tribelos	3		
EPHEMEROPTERA			
Acentrella			1
Caenis latipennis	8	18	2
Callibaetis			1
Hexagenia limbata	2		
Leptophlebiidae			1
Stenacron	1		6
ISOPODA			
Caecidotea	1	3	
LIMNOPHILA			
Lymnaeidae	2		2
Physella		6	1
MESOGASTROPODA			
Hydrobiidae		12	1
ODONATA			
Argia		4	
Enallagma		1	
RHYNCHOBDELLIDA			
Piscicolidae	1		
TRICHOPTERA			
Cheumatopsyche			4
Ironoquia		-99	1
Triaenodes		2	
TRICLADIDA			
Planariidae	1		
TUBIFICIDA			
Enchytraeidae		1	
Ilyodrilus templetoni	2		
Limnodrilus claparedianus	9		
Limnodrilus hoffmeisteri	17	1	1
Tubificidae	63		2
VENEROIDA			
Pisidiidae	1		

Aquid Invertebrate Database Bench Sheet Report
Black Cr [1004056], Station #6, Sample Date: 4/13/2010 10:55:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	12	1	1
AMPHIPODA			
Crangonyx	7	35	
ARHYNCHOBDELLIDA			
Erpobdellidae	-99	-99	
COLEOPTERA			
Dytiscidae		1	
Peltodytes		1	
DECAPODA			
Orconectes		-99	
DIPTERA			
Ablabesmyia	1	5	
Ceratopogoninae	1		
Chironomidae	12	9	4
Chironomus	3	1	
Cladotanytarsus	4		
Cricotopus/Orthocladius	46	116	105
Cryptochironomus	1		
Cryptotendipes	18		
Dicrotendipes	7	5	58
Diplocladius		2	
Eukiefferiella			3
Glyptotendipes	1	1	13
Hydrobaenus	21	8	5
Microtendipes	1		
Paracladopelma	6		
Parakiefferiella	9	63	8
Paralauterborniella	2		
Paratanytarsus	2	4	2
Phaenopsectra	9	5	2
Polypedilum convictum		5	8
Polypedilum fallax grp	1		6
Polypedilum halterale grp	11		
Polypedilum scalaenum grp	13	1	5
Rheocricotopus		2	
Saetheria	1		
Simulium	1	2	3
Stenochironomus			5
Tanytarsus	33	32	17

Aquid Invertebrate Database Bench Sheet Report
Black Cr [1004056], Station #6, Sample Date: 4/13/2010 10:55:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Thienemannimyia grp.	2	4	2
Tribelos	2		
Zavrelimyia	1	1	
EPHEMEROPTERA			
Caenis latipennis	2	1	
Leptophlebiidae	1	5	
Stenacron			1
HEMIPTERA			
Sigara	1		
ISOPODA			
Caecidotea	2	2	
LIMNOPHILA			
Lymnaeidae			2
Physella		-99	
MESOGASTROPODA			
Hydrobiidae	4	7	1
ODONATA			
Libellulidae	1	2	
Nasiaeschna pentacantha		-99	
TRICHOPTERA			
Ironoquia		3	1
Triaenodes		2	
TUBIFICIDA			
Aulodrilus	1		
Enchytraeidae	10	5	2
Limnodrilus claparedianus	3		
Limnodrilus hoffmeisteri	9	1	
Tasserkidrilus superiorensis	2		
Tubificidae	46		2
VENEROIDA			
Pisidiidae	2		